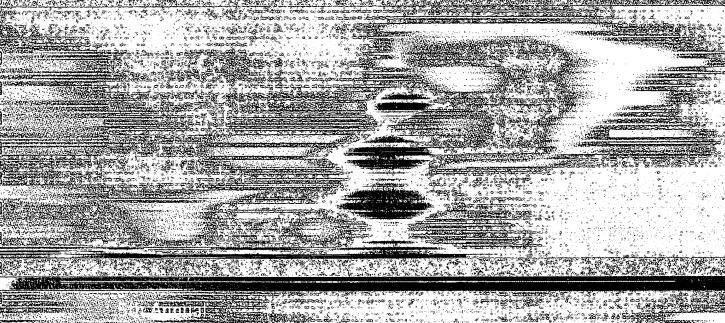
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Worders W

THE PROBLEM

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THE PROBLEM

このの情報が、1000年代の1000年代に対し、このの情報を開発している。 1000年代の100日代の10

Technicians

Technicians
Technicians
Assignments

The state of the s

Technicians /

Assignments /

Constraints

で優好しいである!

1. The Computation of Conference Computation (Conference Computation Conference Conference

Technicians /

Assignments /

Constraints

Heuristics

Annapa napan

METBOYLEM

・ という こうかい 会議を示す サンチャ 主張 こうかいり できる 液性の物質素質素がある こうないかかい

Orders

Technicians

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THE PARTY OF THE P

Assignments

Constraints

Heuristics

Objectives

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からいのはいるののはないのです。

Technicians

Assignments

Appointments

Constraints

Objectives

Heuristics

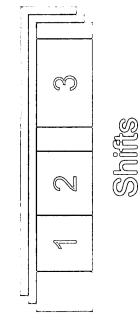
## FIRST GENERATION SYSTEMS

To Community And Andrews Manager Man

Appointment Negotiation

Order Assignment





10 Techs 10 Hours

10 Techs 10 Hours

10-11

# SECOND GENERATION SYSTEMS

- · [Mathematical optimization
- Rules-based ("expert system")
- · Solving the wrong problem
- · Don't focus on our domain

#### OUR APPROACH

Wednesday 2 Ø Tuesday (S) Ť Monday Tech 1 123 Tech 2

1. Orders Always Assigned

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大学では、他のでは、これによっては、日本のではのでは、日本のでは、日本のでは、日本のでは、日本のでは、日本のでは、日本のでは、日本のでは、日本のでは、日本のでは、日本のでは、日本のでは、日本のでは、日本のでは、日本のでは、日

2a. Appointments Negotiated Against Schedule 2b. Orders Booked Against Schedule 3

Monday Tuesday Wednesday

1. Orders Always Assigned

2a. Appointments Negotiated Against Schedule 2b. Orders Booked Against Schedule

Monday

Tuesday

Wednesday

6

Tech 1 [12] 3

0

Tech 2

3. Orders Continuously

Optimized

1. Orders Are Always Assigned

OPTIMIZATION

1. Moves

123

7

1. Moves

2. Swaps

Ţ 7

0

©\ ©Ø

2

> All related concepts have to be re-visited

#### SELECTED TOPICS

1. Configurability

5. Long Duration Orders

2. ESS as a Component

6. Modifying Orders

3. Appointment Windows

7. Order States

4. Bumping/Load Groups

#### 1. CONFIGURABILITY

TOTAL TOTA

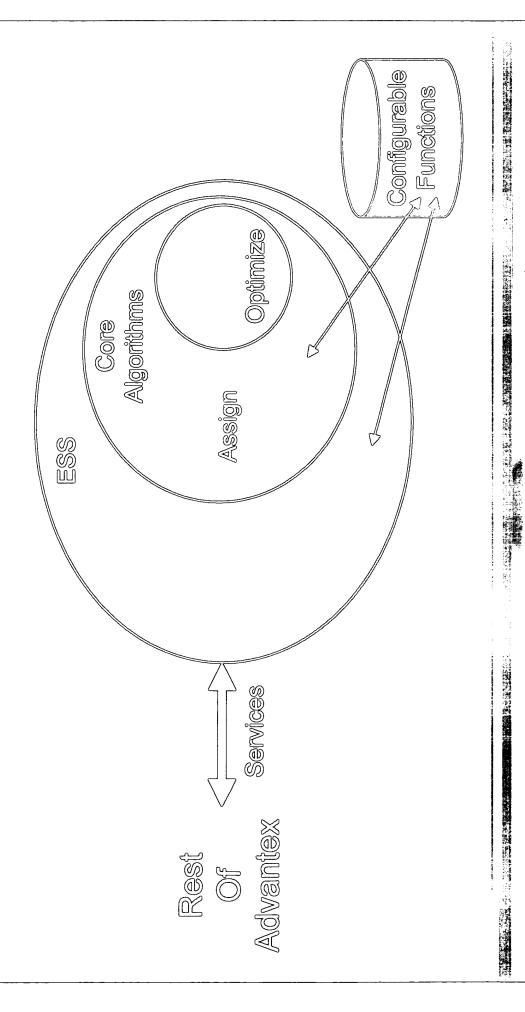
- Travel time and work duration
- Suitability of assignments (candidacy)
- Optimization objectives

- . Configurable logic
- Based on fixed and configurable fields
- Based on scenarios

の言っ音

2. SCALABILITY AND FLEXIBILITY

The second of th





- Guaranteed commitment
- Windows offered in prioritized list
- · Arbitrary window definitions
- Overlapping, different sizes, multiple "levels"
- Different windows for different types of orders

・放映機能は多いでは機能はは発達さればは、Managaranterの機能は機能は緩緩にはない。 かいかい Andrews Managaranterの こうかい かいかだけ

No time sense distinction

""current", "future", and "undated"

Each order has an appointment window

· Each order has a priority

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· COMMENSATION OF THE COM

A. M. L. Ser.

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SNIJMNS

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### PRIORITY ESCALATION

の意味が、一定では、こので、このははなる機能を発行して、この機能を発展されるので

Tuesday

Monday

Priority

Wednesday

には、1911年の1

A. The state of th



The state of the s

# LOAD GROUPS AND RESERVE CAPACITY

Load Priority Level

Reselve

Capacify

High

100%

35%

**@2**%

Medium

45%

20%

10 miles

5. LONG DURATION (SPLITTABLE) ORDERS

 Wednesday Tuesday Monday



5. LONG DURATION (SPLITTABLE) ORDERS

Monday

Tuesday

Wednesday

5. LONG DURATION (SPLIITABLE) ORDERS 1971年 1971年 1971年 1971年 1981年 1981年

Tuesday

Monday

Wednesday

6. MODIFYING ORDERS

・部分の人を存在的は機能があり、これの行うに対象的の研究の「対象の教育な理解を示し

Verify assignment is still valid

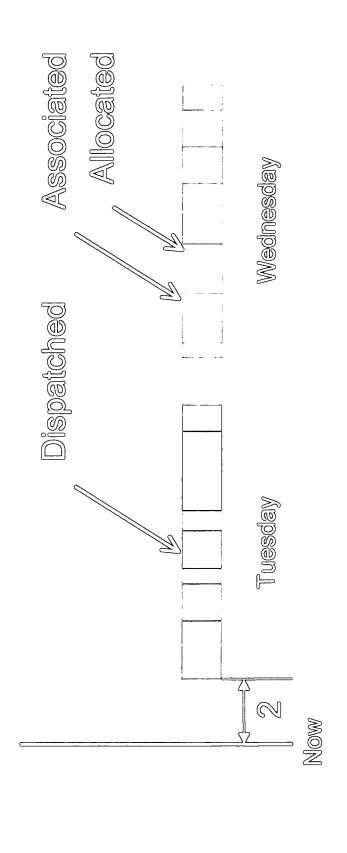
Reject with detailed error information

Allow override

7. ORDER STATES, WIEWING THE SCHEDULE

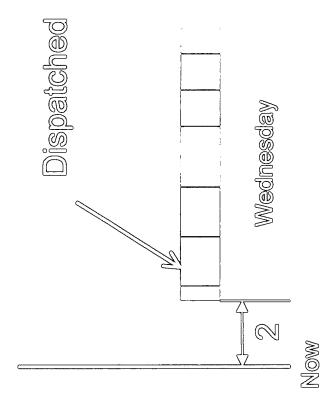
Wednesday Associated Allocated Tuesday , 1985年, 1985年,

- プロコロスは、金属電子機能を開発的に対して、プロコールを開発的によって、フロコールの表現の対象を

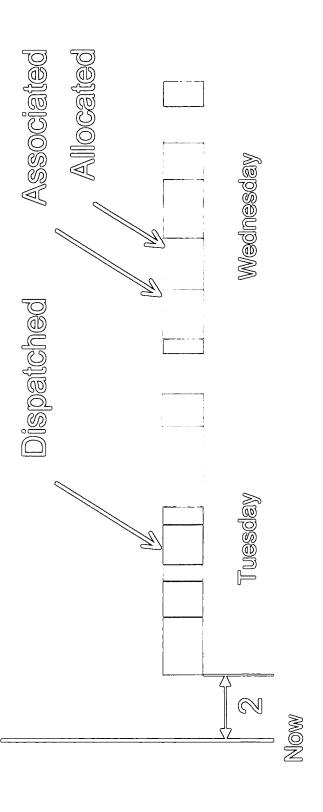


, 1988年 198

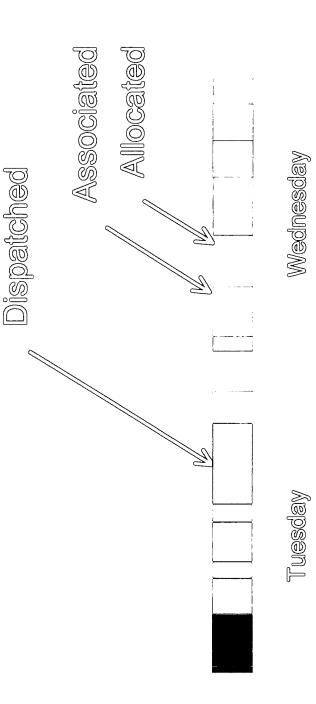
THE PROPERTY OF THE PARTY OF TH



# FLOATING SCHEDULES



## FLOATING SCHEDULES

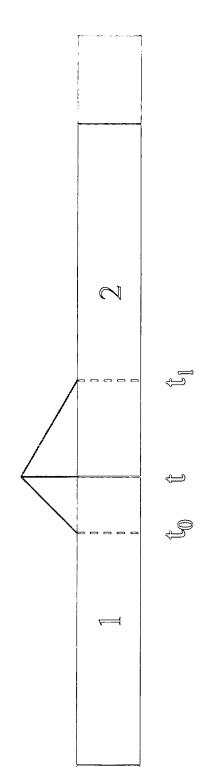


## INTO THE FUTURE

- What-if capability?
- Automatic statistics gathering
- Trend analysis / forecasting
- Probabilistic travel times

PROBABILISTIC TRAVEL AND WORK TIMES

- Participation of the control of



rather than high degrees of optimization Focus on the nuances of the domain

E J S H S L S

DOM WURUL

THE MORE THE PERMITTER

- . Customer Satisfaction
- Technicians on Time
- · Minimise Repeat Visits
- . Quick Response to Urgent Orders
- · Achieved by Meeting Constraints
- . Honour Appointment Windows
- Correct Skills and Equipment for Job
- . High Priority Jobs First

- Efficient Use of Technician Resources

Reduce Travel Time

Compress Schedule

Aggregate Orders

. Achieved by

. Optimising Technician Tours

Consolidating Free Time

Applying User Defined Heuristics

# Schedule Representation

- 4 Individual Time Line for Each Technician
- Schedule Always Feasible
- . Schedule Visible When Needed
- Resource Requirements Always Known
- . Can Accommodate
- · Single Shiff Orders
- · Long Duration Orders
- · Complex Orders

Control of the Contro

Time Line

を できる かいかん

Tech 1

Shiff 1

Shiff 2

Shiff 3

Shift 4

Shift 5

Shiff 4

Shift 3

Tech 2

Shift 2

Shift 3

Shift 2

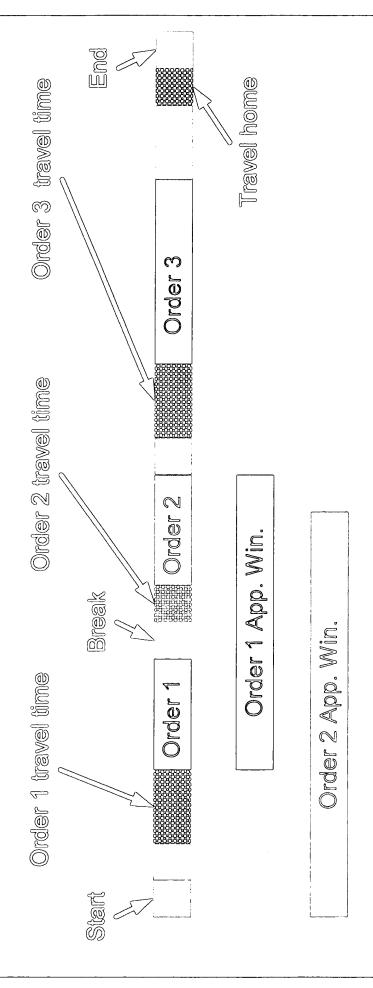
Shiff 1

Tech 3

Shift 4

Time

#### Shift Time Line



Order 3 Appointment Window

) で の に で

### Assignment Goals

- · Valid Assignment of Technician to Job
- User Defined Candidacy Function
- Skills, Equipment, Business Unit, etc.
- Honour Appointment Windows
- . Honour Technician Load Levels
- Quick Response from System
- . Get Candidate Shifts
- . Insert Order

というのでは

# Assignment Facilitated By

- 4 Inserting Orders Into Free Time Blocks
- · Shiffing Existing Orders
- . Bumping Existing Orders
- . Based on Effective Priority
- · Effective Priority Changes With Time
- . Bump as Needed / on Approval
- · Inserting Orders Between Existing Orders

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And the Control of th

Shiffing Orders

## Bumping Orders

Cannot Bump

Bump at Will

Bump at Will

Bump on Approval

Order

Order2

Order 3

Free

Order 4

S

Order

Order 4

Virtual Free Time Block

Order 1

Order 5

Additional Travel

Yielded by "Bump

at Will" and Free

Time to Order 4

Order 1

Virtual Free Time Block

Order 5

New Travel Time to

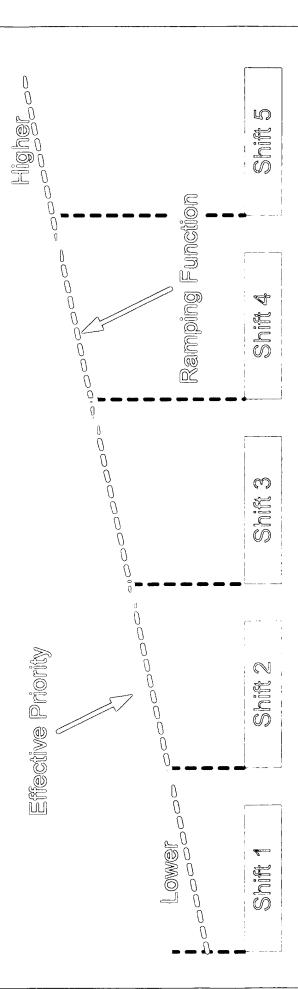
Order 5

Approval

Includes "Bump on

# Effective Priority Escalation

・ Processing Company Company



Time

- · Using Technicians in Backup Areas
- . Search Primary Area First
- · Expand Search into Backup Areas
- · User Defined Candidacy Function
- . Can Define Search Within Backup Areas
- E.g. Search Nearest Backup Areas First
- · Penalty Function to Restrict Movement

のへをお言う言

· Reduce Travel Time By

Re-sequencing Orders Within Shift

Re-sequencing Orders Between Shifts

Aggregating Orders

Travel Time Function User Defined

Reduce Schedule Fragmentation By

. Compressing Schedule

· Travelling Salesman Problem

. Problem is Order Ni

> 69! is order 1098

. Time Window Constraints

Cannot Do Exhaustive Optimisation

· Want a "Good" Solution

## A Multi-phased Approach

- Optimise a Single Shift
- . Objective Function is Travel Time
- Re-seduence Orders
- . Must Honour Constraints
- · Appointment Windows
- · Minimum Work Before Breaks

**じ** 

Single Shift Optimisation - Before

 $\mathbb{N}$ 

 $\mathbb{C}$ 

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 $\mathcal{C}$ Single Shift Optimisation - After 

## Optimisation Over Time

- Rolling Window for Intra-shift Optimisation

Current

Time

Tech 1:

Shiffed

Shift 2

Optimisation Window

Min. Time to Travel

Shiff

Shift 4

Shiff 5

Tech 2: Shift 1

Shift 2

Shiff 3

Shift 4

Shift 5

Shiff 6

Min. Time to Travel

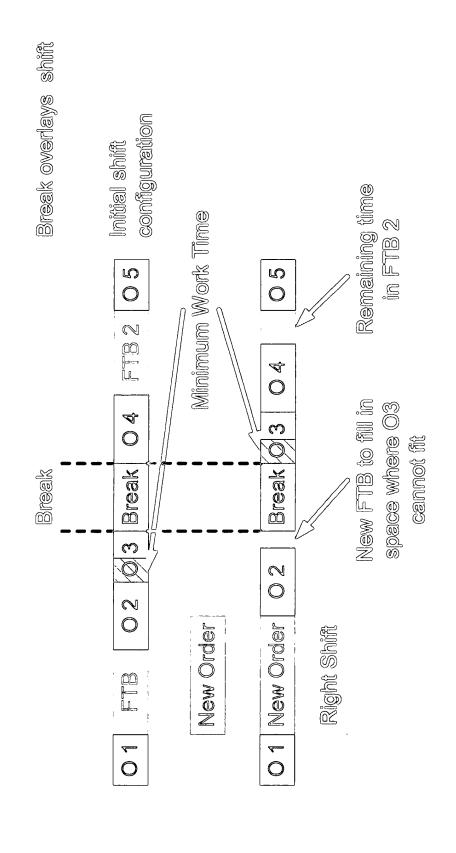
Optimisation Window A CONTRACTOR OF THE PARTY OF TH

#### Order Swapping

- · Appointment Window Overlap
- · "Drop-in" and "Shiff" activities
- Simpliffes Algorithm
- . Shift in One Direction Only
- Propagates as Far As Other Swapped Order
- · Breaks Complicate Shifting of Orders

# Breaks And Order Shiffing

いた。1987年には、1987年では、1997年では、1987年では、1987年には、19



# Appointment Window Overlap

(1) 在外域域域的设计,是是一种是一种的数据域域域域的现代,

Appointment Window overlap

Order 1

Order 2 Appointment Window

Order 1 Appointment Window

Order 2

Earliest times after swap:

Order 2 Order 1

Order 1

Order 2

Latest times after swap.

Other orders in this range may need shifting うらっこ

, 1900年, 1900年,

"Drop-in" and "Shift" Activities

Order 2 Order ¥ Order 1 Order X

Order Z Order Z Drop-in Order Y Shift Order X

Order Y shifts right

Order ¥ Order 1 Order X

Order 2

Order Z

Order X

Shift

Order Y

Drop-in

Order Z

Order X shifts left

100 m

# A Multi-phased Approach

- 4 Optimise Pairs of Shifts
- . Qustomer Defined Objective Function
- Customer Defined Candidacy Function
- Swap or Re-assign Orders Between Shifts
- . Must Honour Constraints
- · Appointment Windows
- · Minimum Work Before Breaks
- · Technician Load Levels

**"我们是一个人,我们就是一个人,我们就是一** 

7 Inter Shift Optimisation - Before N 11 Shiff 2 Shiff 1 

Inter Shift Optimisation - After

 $\mathbb{N}$ Shift 1

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4

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Shift 2

The state of the s

## Optimisation Over Time

Folling Window for Inter-shift Optimisation

Current

Time

Shifkij

Shift

Shift 2

Shift 4

Shift 5

Tech 1:

Optimisation

Min. Time to Travel

Window

Shift

STATE OF THE STATE

Shift 1

Shift 4

SHIES STIES

Tech 1:

Optimisation

Min. Time to Travel

Window

Search

Window

TANDEL VA

#### ESS - Goals Met

- J Customer Satisfaction
- System Books to Specific Technician
- . Correct Skills and Equipment
- Order Bumping and Priority Escalation

#### · User Satisfaction

- Efficient Use of Resources
- Visibility Into Schedule
- Quick System Response

E I G S h a r cos Mom Xueul

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